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Section 12.0 – QST 35 Class: Navy and U.S. Coast Guard Spark Ignition Inboard Vessels

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SECTION 12.0 – QST 35 CLASS

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12.0 QST 35 CLASS

The Navy's QST 35 Class of boats was selected to represent the group of vessels powered by inboard spark ignition engines. The QST 35 Class consists of 56-foot target drone launch boats that can be used in manned or remote control operations. There are 29 boats within the QST 35 vessel class. These boats are underway approximately 87 days per year; approximately 52 days are spent operating solely within 12 nautical miles (nm) from shore, and the remaining 35 days are spent operating both within and beyond 12 nm of shore. Because these boats spend the majority of their time operating within 12 nm of shore, it is assumed that all the bilgewater generated by these boats is generated within 12 nm. These boats spend 196 days pierside and are out of the water for maintenance when they are not pierside or underway. The bilgewater generation rate for this vessel class is estimated to be 1.5 gallons per day (gpd) while pierside and 4 gpd while underway. Boats in this class generate approximately 642 gallons of bilgewater within 12 nm annually.

Bilgewater generated within 12 nm from shore:

$$\frac{196\text{ days (pierside)}}{\text{yr}} \bullet \frac{1.5\text{ gal}}{\text{day}} + \frac{87\text{ days (underway)}}{\text{yr}} \bullet \frac{4\text{ gal}}{\text{day}} = 642\text{ gal/yr}$$

There is no oil water separating system installed on-board these boats. Although these boats are equipped with five or six bilge pumps, the crew transfers any bilgewater that has accumulated to a bilge pumping/tanker truck located on the pier using a suction hose. The bilge pumps are primarily used in emergencies when the craft has taken on a significant amount of water. The following marine pollution control devices (MPCDs) are evaluated in this feasibility analysis of QST 35 Class boats: collection, holding, and transfer (CHT); evaporation; gravity coalescence; hydrocyclone; *in situ* biological treatment; oil absorbing socks (OASs); filter media; and membrane filtration.

12.1 COLLECTION, HOLDING, AND TRANSFER (CHT)

The following sections discuss the feasibility and cost impacts of practicing CHT on-board QST 35 Class boats.

12.1.1 Practicability and Operational Impact Analysis

This section analyses specific feasibility criteria relative to the physical characteristics and operational requirements of CHT.

12.1.1.1 Space and Weight

Due to their small size and low bilgewater generation rate, QST 35 Class boats are not equipped with an oil water separator (OWS) or oily waste holding tank (OWHT). These boats practice CHT: generated wastewater is allowed to accumulate in the open bilge spaces and is transferred to a bilge pumping/tanker truck.

The average length of an exercise for these boats is 6 to 8 hours. The bilges on all QST 35 Class boats are pumped dry an average of once every two weeks (Brown, 2000). Therefore, the maximum amount of bilgewater likely to accumulate is approximately 31.8 gallons. This volume of wastewater in the bilge would not result in any measurable impacts to space and weight, or pose a hazard to the operation of the boat.

12.1.1.2 Personnel/Equipment Safety

Practicing CHT does not pose any safety hazards to the boat's crew or equipment. Other than following standard procedures for handling hazardous materials (e.g., oily waste), no special precautions are necessary.

12.1.1.3 Mission Capabilities

Practicing CHT on QST 35 Class boats has not had an impact on boat's mobility, or on any mission critical systems or operations.

12.1.1.4 Personnel Impact

Practicing CHT as a primary control option does not require special training. No more than two crewmembers are needed to offload any wastewater that has accumulated in the bilge spaces (Brown, 2000). Although QST 35 Class boats are equipped with five to six bilge pumps, any bilgewater that has accumulated in the bilge is transferred to a bilge pumping/tanker truck using a suction hose. The bilge pumps are generally for emergency dewatering purposes only and do not have shore connections necessary for transferring bilgewater to shore facilities.

Each QST 35 Class boat generates approximately 642 gallons of bilgewater annually within 12 nm. The boats are pumped dry an average of once every two weeks using a bilge pumping/tanker truck that is driven up to the pier. As calculated above, the volume of bilgewater that accumulates over a two-week period is approximately 31.8 gallons. Using a suction hose from the bilge truck, it takes two crewmembers about 10 minutes per boat to drain the bilge (Brown, 2000). Over a year, the bilge will be pumped approximately 20 times, assuming the boats are out of the water 60 days per year. The total annual labor associated with the transfer of the bilgewater is 7 hours.

$$\frac{10\text{ min}}{\text{event}} \bullet \frac{\text{hrs}}{60\text{ min}} \bullet \frac{2\text{ labor hours}}{\text{hrs operation}} \bullet \frac{20\text{ events}}{\text{yr}} = 7\text{ hrs/yr}$$

No maintenance is required to perform CHT. Table 12-1 provides the annual labor hours required to perform CHT.

Table 12-1. CHT Annual Labor Hours (QST 35 Class)

	MPCD Option: CHT
Operator Hours Within 12 nm	7
Operator Hours Beyond 12 nm	-
Condition-based Maintenance Within 12 nm	0
Condition-based Maintenance Beyond 12 nm	-
Time-based Maintenance	0
Total Time	7

12.1.1.5 Consumables, Repair Parts, and Tools

There are no requirements for consumables, repair parts, or tools associated with CHT.

12.1.1.6 Interface Requirements

Practicing CHT does not require any unique interface requirements. As previously explained, bilgewater that accumulates in these boats is typically transferred to a bilge pumping/tanker truck using a suction hose.

12.1.1.7 Control System Requirements

There are no automated control system requirements associated with CHT.

12.1.1.8 Other/Unique Characteristics

No other/unique characteristics have been identified with respect to this MPCD option.

12.1.2 Cost Analysis

The following cost data and calculations are provided to allow the reader to compare costs associated with a CHT system on the QST 35 Class boat.

12.1.2.1 Initial Cost

Continuing to practice CHT within 12 nm on QST 35 Class boat does not require any equipment or boat modifications. Therefore, the initial cost of practicing CHT is assumed to be zero.

12.1.2.2 Recurring Cost

The MPCD requires 7 personnel hours per year for transfer of bilgewater to shore, as explained under Section 12.1.1.4. The annual labor hours multiplied by the $22.64 per hour MPCD operator labor rate produces the annual recurring labor cost of approximately $151.

$$\frac{\$22.64}{\text{hr}} \bullet \frac{7\ \text{hrs}}{\text{yr}} = \$151/\text{yr}$$

The annual bilgewater generation rate within 12 nm is 642 gallons. Multiplying the volume of bilgewater generated annually within 12 nm by the oily waste disposal unit cost produces an annual recurring disposal cost for CHT on a QST 35 Class boat of $48.

$$\frac{642\text{ gal}}{\text{yr}} \bullet \frac{\$0.0749}{\text{gal}} = \$48/\text{yr}$$

The bilgewater generated annually within 12 nm multiplied by the oily waste disposal unit cost for Coast Guard boats produces the annual recurring disposal cost for CHT on a QST Class boat of $584.

$$\frac{642\text{ gal}}{\text{yr}} \bullet \frac{\$0.91}{\text{gal}} = \$584/\text{yr}$$

Table 12-2 summarizes the annual recurring costs of practicing CHT on a QST 35 Class boat.

Table 12-2. Annual Recurring Costs for CHT (QST 35 Class)

Vessel Operating Parameter	Disposal Cost Used	Annual Recurring Cost ($K)
Within 12 nm	Navy	0.199
Beyond 12 nm	Navy	-
Within 12 nm	Coast Guard	.735
Beyond 12 nm	Coast Guard	-

12.1.2.3 Total Ownership Cost (TOC)

Table 12-3 summarizes TOC and annualized cost over a 15-year lifecycle of practicing CHT on a QST 35 Class vessel.

Table 12-3. TOC for CHT (QST 35 Class)

Cost ($K)	Other Military Services Vessel Operation Within 12 nm	Other Military Services Vessel Operation Within + Beyond 12 nm	USCG Vessel Operation Within 12 nm	USCG Vessel Operation Within + Beyond 12 nm
Total Initial	0.0	0.0	0.0	0.0
Total Recurring	2.2	2.2	8.2	8.2
TOC (15-yr lifecycle)	2.2	2.2	8.2	8.2
Annualized	0.2	0.2	0.7	0.7

12.2 CENTRIFUGE

Based on a ship check of a QST 35 Class boat and information provided by service craft personnel, these boats cannot provide the electrical power and potable water required to operate a centrifuge system (Navy, 2000). In addition, adequate space is not available on QST 35 Class boats to accommodate the installation of a centrifuge system (Navy, 2000). Therefore, the use of centrifuges is infeasible and no further analysis will be conducted with regard to the use of centrifuges on QST 35 Class boats.

12.3 EVAPORATION

Based on a ship check of a QST 35 Class boat and information provided by service craft personnel, these boats cannot provide the electrical power required to operate an evaporation system (Navy, 2000). In addition, adequate space is not available on QST 35 Class boats to accommodate the installation of an evaporation system (Navy, 2000). Therefore, the use of evaporation is infeasible and no further analysis will be conducted with regard to the use of evaporators on QST 35 Class boats.

12.4 GRAVITY COALESCENCE

Based on a ship check of a QST 35 Class boat and information provided by service craft personnel, these boats cannot provide the electrical power required to operate a gravity coalescer (Navy, 2000). In addition, adequate space is not available on QST 35 Class boats to accommodate the installation of a gravity coalescence system (Navy, 2000). Therefore, the use of gravity coalescence is infeasible and no further analysis will be conducted with regard to the use of gravity coalescence on QST 35 Class boats.

12.5 HYDROCYCLONES

Based on a ship a ship check of a QST 35 Class boat and information provided by service craft personnel, these boats cannot provide the compressed air required to operate a hydrocyclone system (Navy, 2000). In addition, adequate space is not available on QST 35 Class boats to accommodate the installation of a hydrocyclone system (Navy, 2000). Therefore, the use of hydrocyclones is infeasible and no further analysis will be conducted with regard to the use of hydrocyclones on QST 35 Class boats.

12.6 *IN SITU* BIOLOGICAL TREATMENT

In Situ biological treatment of bilgewater is the addition of microbes to a boat's bilge spaces to digest the oil content of the bilgewater. For *in situ* biological treatment to be effective, the microbes must be left in the bilge for a sufficient period of time to digest the bilgewater's oil content. According to the vendor, the most effective use of *in situ* biological treatment for the wastewater that accumulates in the bilge is to leave the *in situ* material in the bilge spaces on the boat for a 30-day period to establish a population of microbes (Opsanick, 2000). *In situ* material could be left in the bilge spaces to reduce the oil content of any bilgewater generation that might occur. However, QST 35 Class boats practice CHT without significant cost or operational impacts. Because CHT prevents the discharge of bilgewater, *in situ* biological treatment would not provide any additional benefit. Therefore, no further analysis will be performed for the *in situ* biological treatment MPCD option.

12.7 OIL ABSORBING SOCKS (OASS)

OASs are designed to absorb oil found floating on the surface of a body of water (Sorbent Products, Inc., 2000). In this application, OASs would be placed inside the bilge areas of a QST 35 Class boat to continuously absorb the waste oil from the bilgewater. When the OASs become fully saturated, they are manually removed and replaced with new OASs. This use of OASs for QST 35 Class boats poses a concern regarding both the potential to affect emergency dewatering and the potential to serve as a fuel source for fire.

The presence of OASs in the bilge spaces could potentially restrict or prevent the flow of bilgewater through the normal and emergency dewatering pumps and strainers by clogging the suction points. The Navy and Coast Guard prohibit (through practice) the presence of any loose materials or debris in the bilge areas for this reason. Furthermore, as the OAS absorbs oil it becomes a potential fuel source that could contribute to the intensity of an engine room fire.

Based on the potential operational and safety impacts related to emergency dewatering and fire hazards on QST 35 Class boats, OASs are not a feasible MPCD option group for QST 35 Class boats.

12.8 FILTER MEDIA

The following sections discuss the feasibility and cost impacts of installing and operating an in-line filter on-board QST 35 Class boats.

12.8.1 Practicability and Operational Impact Analysis

This section analyzes specific feasibility criteria relative to the physical characteristics and operational requirements of the in-line filter unit.

12.8.1.1 Space and Weight

The in-line filter selected for the analysis is manufactured specifically for small boats and is representative in size and capacity of the in-line filters on the market.

According to the vendor, some commercial boats have had limited success installing in-line filter units between their bilge pump and the overboard hull fitting. Table 12-4 provides the space and weight for a complete 50-2000 gallon per hour capacity in-line filter system.

Table 12-4. In-line Filter Specifications (QST 35 Class)

Physical Properties	Number of Units	Capacity	Size (ft.) L x W x H	Maintenance Envelope (ft.)	Volume (ft^3)	Weight (lbs.) Dry/Flooded
Per unit	1	50-2000 gph	12.5 x 5.25	Approx. 24 x 10	271	3.5/6.5
Total (To achieve required processing capacity)	1	50-2000 gph	-	-	271	3.5/6.5

12.8.1.2 Personnel/Equipment Safety

There are no unusual personnel or equipment safety hazards associated with in-line filter systems. Other than wearing standard personal protective equipment (e.g., rubber gloves/boots and safety glasses/goggles) during maintenance activities, no special devices or precautions are necessary. Any hazardous materials (e.g., oil and grease) required for operation and maintenance are minimal in quantity and authorized for use. Standard afloat control and management procedures are adequate for use and disposal of the material.

12.8.1.3 Mission Capabilities

The installation and operation of an in-line filter unit on a QST 35 Class boat are not expected to have an impact on ship's signature, war fighting capabilities, mobility, or on any mission critical systems or operations.

12.8.1.4 Personnel Impact

The in-line filter unit runs in automatic mode, but requires general supervision while the unit is operating. With a total processing rate of 50 gph and a total of 642 gallons of effluent to be processed annually, the filter media will have to be operated 12 hours per year. Every two hours, 0.25 hours (15 minutes) of general oversight is assumed. The annual labor requirement associated with in-line filter oversight is 1.6 hours.

$$\frac{642\text{ gal}}{\text{yr}} \bullet \frac{\text{hr}}{50\text{ gal}} \bullet \frac{0.25\text{ hrs labor}}{2\text{ hrs}} = 1.6\text{ hr labor/yr}$$

The recovered waste oil is absorbed into filter cartridges that must be offloaded as solid waste or taken to an oil recycling station. The time required to replace a filter cartridge is estimated at 1 hour. Each in-line filter unit comes equipped with a single filter cartridge, thus the total replacement time is one hour. Based upon the low bilgewater generation rate, the expected bilgewater mix, and low operational time period, labor hours associated with filter cartridge replacement and disposal are expected to be negligible.

Annually, the in-line filter requires 0 personnel hours of time-based maintenance, 0 personnel hours of condition-based maintenance within 12 nm, and 0 personnel hours of condition-based maintenance beyond 12 nm.

Table 12-5 provides the annual labor hours required to operate and maintain the proposed MPCD discussed in this section.

Table 12-5. Filter Media Annual Labor Hours (QST 35 Class)

	MPCD Option: In-line Filter
Operator Hours Within 12 nm	1.6
Operator Hours Beyond 12 nm	0
Condition-based Maintenance Within 12 nm	0
Condition-based Maintenance Beyond 12 nm	0
Time-based Maintenance	0
Total Time	1.6

12.8.1.5 Consumables, Repair Parts, and Tools

The in-line filter unit requires filter cartridge replacement. Spare cartridges may be stored on the boat or shoreside. No special repair parts or tools are required for the operation or maintenance of this unit.

12.8.1.6 Interface Requirements

No specific system interface requirements are associated with the in-line filter unit.

12.8.1.7 Control System Requirements

The in-line filter unit does not have any unique control system requirements.

12.8.1.8 Other/Unique Characteristics

In-line filter technology has been used on many small commercial boats and has been tested and used on relatively low contaminant bilgewater. Bilge areas that are full of sediment may require a pre-filter to screen sediments that might otherwise foul and clog the oil-absorbing canister.

12.8.2 Cost Analysis

The following cost data and calculations are provided to allow the reader to compare costs associated with using a filter media system to treat bilgewater on a QST 35 Class boat.

12.8.2.1 Initial Cost

The in-line filter system procurement cost is $110 per unit and the related hardware is $330, which is a total initial cost of $440 per boat (Liberty Bay Solutions, 2001). Based on the Navy’s Alteration and Installation Team (AIT), the installation of in-line filter systems for the fleet of QST 35 Class boats will cost $36,200 ($1,250 per boat). Technical manuals, drawings and integrated logistic costs will be $14,000 ($500 per boat) (Navy, 2000). The total initial cost of an in-line filter system on a QST 35 Class boat is $2,190 per boat.

12.8.2.2 Recurring Costs

This MPCD requires 1.6 personnel hours per year for operation within 12 nm, as explained under Section 12.8.1.4. The number of annual labor hours multiplied by the $22.64 hourly MPCD operator labor rate produces the annual labor cost within 12 nm.

$$\frac{\$22.64}{\text{hr}} \bullet \frac{1.6\text{ hr}}{\text{yr}} = \$36/\text{yr}$$

The cost of a new filter cartridge along with the replacement and disposal of the old cartridge is negligible.

Table 12-6 summarizes the annual recurring costs of using the in-line filter on a QST 35 Class vessel.

Table 12-6. Annual Recurring Costs for a Filter Media System (QST 35 Class)

Vessel Operating Parameter	Disposal Cost Used	Annual Recurring Cost ($K)
Within 12nm	-	0.036
Beyond 12nm	-	-

* *Because the filter media system does not require either the transfer of waste oil or oily waste water to shore facilities, disposal costs were not calculated for this MPCD option.*

12.8.2.3 Total Ownership Cost (TOC)

Table 12-7 provides the TOC and annualized cost over a 15-year lifecycle of using a filter media system on a QST 35 Class vessel.

Table 12-7. TOC for Filter Media (QST 35 Class)

Cost ($K)	Other Military Services Vessel Operation Within 12 nm	Other Military Services Vessel Operation Within + Beyond 12 nm	USCG Vessel Operation Within 12 nm	USCG Vessel Operation Within + Beyond 12 nm
Total Initial	2.19	2.19	2.19	2.19
Total Recurring	0.4	0.4	0.4	0.4
TOC (15-yr lifecycle)	2.6	2.6	2.6	2.6
Annualized	.2	0.2	.2	0.2

12.9 MEMBRANE FILTRATION

Based on a ship check of a QST 35 Class boat and information provided by service craft personnel, the Navy's AIT has concluded that adequate space is not available on QST 35 Class boats to accommodate a membrane filtration system (Navy, 2000). Furthermore, installation of a secondary treatment, such as membrane filtration, requires the installation of a primary OWS. Because QST 35 Class boats cannot accommodate a primary OWS, membrane filtration is not able to operate properly on this vessel class. Therefore, the use of membrane filtration is infeasible and no further analysis will be conducted with regard to the use of membrane filtration on QST 35 Class boats.